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An Introduction to Cultural Neuroscience

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This chapter's goal is to serve as a brief introduction to the emerging field of cultural neuroscience. It does not intend to provide an extensive review but rather a brief overview of the field. We start by defining cultural neuroscience and follow by providing important reasons for doing research in this field. Next we explain some key terms and methodologies. We then highlight important studies in the field and provide recommendations for designing a study. Finally, we make suggestions for future directions. Throughout this chapter, we choose a few specific examples to illustrate ways in which cultural neuroscience researchers have utilized the concepts and tools described here.

What Is Cultural Neuroscience?

Cultural neuroscience is an emerging interdisciplinary field that combines theories and methods from cultural and social psychology, anthropology, and social and cognitive neuroscience to investigate the interactions between culture, psychological processes, brain, and genes at different timescales (for reviews, see Chiao, Cheon, Pornpattananangkul, Mrazek, & Blizinsky, 2013; Han et al., 2013; Kim & Sasaki, 2014). Because of the broad interdisciplinary nature of the field, describing all of the different ways in which cultural neuroscientists do research in this area is beyond the scope of this chapter. Here we will be focusing on the most common method, which is representations in the brain through neuroimaging techniques.

Because this field lies at the intersection of many areas of study, we begin by describing how cultural neuroscience derives from each of these

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disciplines. First, it borrows from anthropology and cultural and social psychology by assuming that people's sociocultural environments largely shape how they think and behave. Second, it takes tools and theories from social and cognitive neuroscience to investigate neural mechanisms of social and cognitive phenomena in different contexts (Ochsner & Lieberman, 2001). Taken together, cultural neuroscience combines findings and methods from these various fields to study sociocultural variations in cognitive and social processes and how they are represented in the brain. It aims to uncover how repeated engagement in different sociocultural environments might influence the brain (Kitayama & Uskul, 2011).

It is important to note that cultural neuroscience does not intend to be a way of classifying people into categories. In other words, its goal is not to show that differences in brain activity among cultural groups are hard-wired; instead, it demonstrates the opposite: how our brain is shaped by and responds to our sociocultural environment, how malleable and flexible it is in response to its surroundings (Han et al., 2013). In addition, it is important to point out that cultural neuroscience does not necessarily look at neural similarities and differences between races and nationalities but rather at those between cultures (Chiao & Ambady, 2007; Chiao et al., 2010). Indeed, some cultural neuroscience studies have looked at differences in neural activity between people of the same race and same nationality but who come from distinct sociocultural backgrounds, such as people of different religions (Han et al., 2008; Han et al., 2010), socioeconomic backgrounds (Varnum, Blais, Hampton, & Brewer, 2015), or cultural values (Ray et al., 2010). It is clear that a more exact definition of these different constructs is needed, and so we expand on this issue in the following sections.

Why Study Cultural Neuroscience?

One of the main strengths of cultural neuroscience is that it helps bridge the gap between culture and biology (culture–biology interplay; see Causadias, Telzer, & Gonzales, chapter 1 in this volume). Integrating the study of culture with neurobiological processes improves our understanding of the relationship between brain and behavior. Using neuroscience to understand cultural influences on the brain is also advantageous because much of culture rests outside of conscious awareness, and so using brain-imaging techniques allows researchers to get at processes that are not readily available at the conscious level through self-reports.

Another reason to study cultural neuroscience is to get a better understanding of the extent to which psychological processes and their associated neural activity are universal or culture-specific. To date, most psychology and neuroimaging studies have been conducted with Western samples. Indeed, about 90% of fMRI studies have come from countries of Western origin (Chiao, 2009). Furthermore, most psychological studies have been conducted with Westerners, who only account for about 12% of the world population (Arnett, 2008). As many of the studies in the field of cultural neuroscience have already shown, there exist variations in psychological and neural processes between people from different cultural groups. Thus, cultural neuroscience studies can provide a more complete view of the universality of psychological and neural processes.

In an increasingly global and multicultural world, it is important to investigate differences in issues related to cultural diversity, such as discrimination, prejudice, and racism. Learning how culture can influence people's perceptions of and interactions with others at both behavioral and neural levels could lead to greater understanding and improved relationships among intercultural groups. Studying cultural neuroscience can increase our understanding of how explicit and implicit beliefs, values, and behaviors shape the neural mechanisms that underlie differences in psychological processes and behaviors across cultures, and may ultimately reduce intergroup conflict.

Key Terms and Methods

Measuring the Brain

One of the main interests of cultural neuroscientists is determining the patterns of brain activity that underlie sociocultural differences in cognitive, affective, and behavioral processes. A common way to do this is to measure neural activity in two groups of subjects who were brought up in different sociocultural environments and then compare and contrast their brain activity in response to a certain task. The assumption is that differences in sociocultural environments might result in divergent cognitive, affective, and behavioral processes, and that these variations might be reflected in the brain in distinct ways.

Advances in technology in the past few decades have given rise to various ways to measure brain activity. For example, different methods of looking at brain activity include the use of functional magnetic resonance imaging (fMRI), electroencephalography (EEG), transcranial magnetic stimulation (TMS), and functional near-infrared spectroscopy (fNIRS). Each technique measures brain activity in a different way, such as by tracking changes in blood flow (fMRI) or measuring electrical activity in the brain (EEG), and each method has its strengths and limitations. fMRI has advantages and disadvantages compared with other methods of measuring neural activity. On the one hand, one of its strengths is that it has relatively high spatial resolution and is non-invasive. On the other hand, one of its weaknesses is that because the hemodynamic response (see next paragraph for clarification) is very slow (it reaches its peak about 5–6 seconds after the onset of a neural stimulus), its temporal resolution is low compared to that of other techniques such as EEG, which allows millisecond temporal resolution. Of the various techniques available to measure brain activity, this chapter focuses on the method most commonly used by cultural neuroscientists: fMRI.

fMRI is a functional neuroimaging technique that measures changes in blood flow in the brain. The basic idea is that when the brain performs a certain task during a brain scan, more blood will flow into the areas of the brain that are being recruited for the task at hand or, in some cases, fMRI can measure changes in blood flow in a resting brain void of any task demands. One of the most common ways in which changes in blood flow are measured is by keeping track of the levels of oxygenation and deoxygenation in the blood, a contrast known as the blood-oxygen-level-dependent (BOLD) signal. When blood flows to a certain area of the brain, it indicates that those brain cells are being used. This is known as the brain's hemodynamic response, which serves as a proxy for areas of the brain that become active. The activation brain maps produced by fMRI can then be analyzed by means of a variety of techniques, including univariate (looking at overall mean differences in activation between conditions) and multivariate (looking at distributed patterns of brain activation between groups and conditions) analyses.

Key Terms for Regions of the Brain in Cultural Neuroscience

Some neuroscience terms are commonly used when we discuss the brain (see Table 16.1 and Figure 16.1). Researchers refer to frontal parts of the brain using terms such as anterior and rostral, while areas towards the back of the brain are referenced by words such as posterior and caudal. Superior and dorsal areas are towards the top of the brain, while inferior and ventral areas are towards the bottom. Brain images may be displayed in

Table 16.1 Abbreviations and jargon used in cultural neuroscience

Term	Meaning
MPFC	medial prefrontal cortex
pSTS	posterior superior temporal sulcus
VS	ventral striatum
TPJ	temporoparietal junction
FFA	fusiform “face” area
ACC	anterior cingulate cortex
VLPFC	ventrolateral prefrontal cortex
anterior	towards the front of the brain
posterior	towards the back of the brain
rostral	towards the front of the brain
caudal	towards the back of the brain
dorsal	towards the top of the brain
ventral	towards the bottom of the brain
superior	towards the top of the brain
inferior	towards the bottom of the brain
lateral	away from the middle of the brain
medial	towards the middle of the brain

an axial, coronal, or sagittal plane (see Figure 16.1). Specific brain regions are usually associated with certain psychological processes. For example, areas frequently activated when thinking about others (or mentalizing) include the temporoparietal junction (TPJ), the posterior superior temporal sulcus (pSTS), and the dorsomedial prefrontal cortex (dMPFC) (Frith & Frith, 2006). An area commonly associated with thinking about the self is the medial prefrontal cortex (MPFC; Johnson et al., 2002; Kelley et al., 2002; see Varnum & Hampton, chapter 18 in this volume). The ventral striatum (VS) is commonly implicated in reward processing, including the receipt and anticipation of primary and secondary rewards (Delgado, 2007). Finally, the amygdala is involved in emotion processing: it detects salient cues in the environment, and is activated by both threatening and positive emotional stimuli (Hamann, Ely, Hoffman, & Kilts, 2002; see Figure 16.2). Meta-analyses and sources such as the website Neurosynth.org (Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011), which synthesizes results from multiple neuroimaging studies, are helpful for identifying

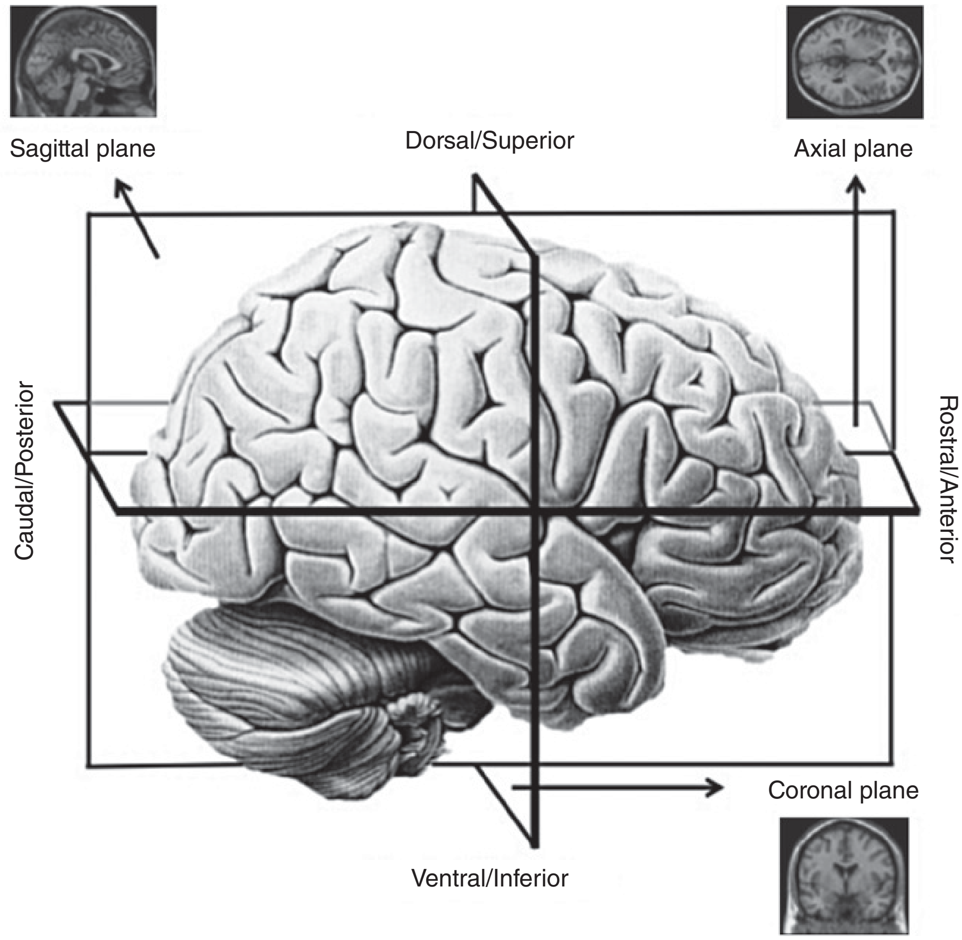

Figure 16.1 Terms commonly used for different parts of the brain

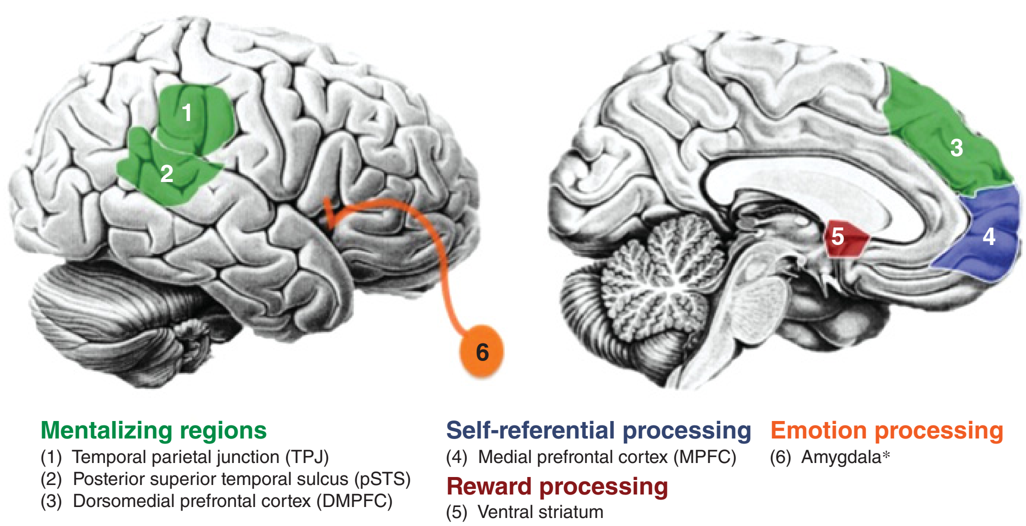

Figure 16.2 Brain regions commonly activated when the brain performs mentalizing, self-referential, and reward- and emotion-processing tasks. *Indicates subcortical structure

regions that might be associated with the psychological process of interest. In some cases, more exploratory analyses might be done in which there are no *a priori* hypotheses about which regions might be activated.

Defining Culture

It is important to define culture and make the distinction between culture, nationality, and race. Culture has long been an issue of debate and has been defined in many different ways (Kroeber & Kluckhohn, 1952), but in the social-psychological sense it can be construed as ideas, values, beliefs, and practices shared by a group of people (Chiao et al., 2010). "Nationality," on the other hand, refers to shared membership based on belonging to the same state or nation. People may be of the same nationality (for example, one is native-born and the other has naturalized citizenship) but not necessarily share ideas, values, practices, and beliefs. Likewise, people of the same race, usually categorized as sharing external physical characteristics like skin color and facial features, may have similar ethnic backgrounds but not necessarily share common cultural experiences. For example, Chinese and Chinese Americans belong to the same race but they might not share the same ideas, values, beliefs, and practices (Han et al., 2013).

Measuring and Manipulating Cultural Constructs of Interest

Because of the differentiations between culture, nationality, and race, and because there are similarities between the three concepts, it is important that studies in cultural neuroscience measure the cultural constructs of interest, such as values or beliefs, that are thought to differ between two cultural groups (Han et al., 2013). One way to do this is to use well-validated self-report measures to look at differences between two cultural groups and then test whether there is a relationship between these values and neural responses. For example, self-construal is a construct that has been found to be different in Western and East Asian societies. On the one hand, East Asians tend to have an idea of the self that is interdependent. That is, the self is thought of as encompassing not just the person itself but also close others. On the other hand, Western societies tend to have a more independent view of the self, where the self is thought of as very different from others (Markus & Kitayama, 1991). Thus, a well-validated measure that gets at individual differences in independent and interdependent self-construals, such as the Self-Construal Scale (Singelis, 1994), can be used to measure cultural values. Measuring the cultural construct of interest, rather than assuming that people from the same nationality or race share similar cultural experiences, may allow researchers to address both the within and the between variability shown by members of the same and different cultural groups. Because people from the same culture might adhere to certain cultural values more than others, evaluating cultural values helps researchers measure within- and between-group individual differences and is one way to disentangle culture from other concepts such as race and nationality.

A method commonly used in cultural neuroscience to assess the relationship between cultural values and neural activity is cultural priming. Cultural priming rests on the assumption that individuals can possess awareness of multiple cultural systems at the same time. Through cultural priming, researchers can temporarily heighten awareness of one cultural value over another (explicitly or implicitly) by using contextual cues (Hong, Morris, Chiu, & Benet-Martinez, 2000), which leads individuals to use mindsets and behaviors that are more consistent with the primed culture. Researchers can then test the effects of this manipulation on behavior and neural processes. For example, priming individuals to have a more independent or interdependent self-construal can result in participants' using different cognitive processes related to each construct. Because different cultural priming techniques have different effects on cognitive and social processes, it is important to use a manipulation that is appropriate to the task at hand (Chiao, 2009; Oyserman & Lee, 2008). One way to use this technique in cultural neuroscience is to prime participants with a cultural value, such as self-construal, before they perform a task in the fMRI scanner (see Meyer, chapter 17 in this volume). For example, Sui and Han (2007) used self-construal priming (they asked participants to read essays and count the number of independent pronouns, such as "I," and the number of interdependent pronouns, such as "we," in them) to examine the resulting neural activity while making face orientation judgments about their own faces and familiar faces. They found that a certain area of the brain (the prefrontal cortex) was activated more when the subject was making self versus familiar judgments, and that this difference was even greater after independent than after interdependent self-construal priming, illustrating how cultural priming can modulate neural activity of self-awareness related to recognition of one's own face. This kind of paradigm illustrates the dynamic nature of culture and can help researchers make more causal inferences regarding the relationship between cultural values and neural activity. However, when using priming paradigms one should also be careful to utilize well-validated priming techniques; this is especially important in neuroscience studies because the effects can sometimes be too small to be detected using fMRI (Powers & Heatherton, 2013).

Making Cross-Cultural Comparisons

The vast majority of studies in cultural neuroscience look at whether behavioral similarities and differences between cultural groups might reveal dissimilar underlying patterns of brain activity. There are various ways in which this might be shown. For example, two different cultural groups may use different brain regions to perform similar behavioral tasks. To illustrate, Tang and colleagues (2006) found that native English speakers used language-related regions, such as the left perisylvian cortices, and native Chinese speakers utilized more vision- and space-related regions, such as visuo-premotor areas, to perform the same arithmetic task. This example demonstrates how two groups may show similar outcomes at the behavioral level but dissimilar patterns at the neural level, highlighting how biological encoding of numbers is shaped by sociocultural differences in learning strategies and educational systems. Alternatively, two cultural groups may use the same brain regions but in opposite ways. For example, Telzer, Masten, Berkman, Liberman, and Fuligni (2010) found that although Latino and White participants contributed to their families at similar rates in a donation task, Latino participants had increased reward-related brain activity when giving to their family while White participants showed more activation in the same regions when gaining money for themselves. This example illustrates how each group might present with different neural activation in the same brain region, despite the similar behavioral outcome. These findings suggest that the sociocultural meaning or value of the behavior is different across cultural groups: whereas Latino youth may find contributing to their family a rewarding and culturally important behavior, White youth may find the same behavior less rewarding and personally meaningful. These kinds of neural findings complement and support our understanding of how culture might modulate the relationship between brain and behavior.

There are several factors to take into consideration when making cross-cultural comparisons in neuroscience research. For example, it is ideal if all of the data are collected using the same scanner to prevent the possibility that differences in scanner properties or scanning environments influence results. Thus, if data collection is done at two or more different locations, one should be careful to make sure that the fMRI scanner properties at each site allow the data collected at all the places to be comparable. Chiao and colleagues (2010) provide a list of suggestions for reducing cross-site variations in data collection. They suggest that one should (1) use fMRI scanners from the same vendor with the same protocols, (2) conduct inter-scanner reliability and calibration tests to compare signal-to-noise ratio across sites, (3) use the same presentation software and hardware at each site, (4) match the scanning and training environments as closely as possible, (5) utilize culturally appropriate scripts, and (6) run quality assurance tests on the collected data. It is important to take the steps above in order to be sure that any differences found across groups are due not to scanner differences but to functional differences in brain activation between participants.

It is also important to control for other factors that might explain differences seen between cultural groups, including age, gender, education, and socioeconomic status (Han et al., 2013). In addition, when possible, the participants' native languages should be used to minimize the potential confounds of language processing. This is especially important in cultural neuroscience studies, because neural regions that might be activated when performing a task might correspond not to the task effects in which researchers are mainly interested, but to regions related to language comprehension. For example, if a certain region is activated when participants from Culture A, but not those from Culture B, perform a task, the difference in activation might not be a reflection of the different cultural ways in which participants from each group are performing the task, but due to differences in language comprehension or to differences in task difficulty that result from differences in language comprehension. In order to disentangle these two possibilities and eliminate potential noise signals unrelated to the main issues of interest, one should use a participant's native language when possible.

Behavioral and Neural Findings

This section illustrates some ways in which researchers have studied how cultural factors influence psychological processes and their corresponding neural activity. Studies in cultural neuroscience have found cultural differences in neural activation in different psychological domains, including visual perception (Goh et al., 2010; Jenkins, Yang, Goh, Hong, & Park, 2010), attention (Hedden, Ketay, Aron, Markus, & Gabrieli, 2008), mentalizing (Adams et al., 2010; Kobayashi, Glover, & Temple, 2006), and empathy (de Greck et al., 2012). We highlight four studies that demonstrate how cultural neuroscientists have explored brain and culture interactions in the areas of self, emotion, perception, and prosocial behavior. Through these examples, we also illustrate how these empirical studies have used the methods described throughout this chapter.

In the first example, Zhu, Zhang, Fan, and Han (2007) were interested in studying the neural correlates of self-representations between subjects from East Asian (Chinese) and Western (English, American, Australian, and Canadian) backgrounds. Using previous findings that self-representations differ between these two cultures, with East Asians showing a more interdependent view of the self, while Westerners possess a more independent view, Zhu and colleagues (2007) hypothesized that neural regions related to thinking about the self, such as the MPFC, might show similar activation when East Asian participants thought about themselves and about their mother, but that Western participants might show distinct neural activation when thinking about the same targets. To this end, they had participants judge personal trait adjectives about themselves, their mother, or a public person (e.g., former American president Bill Clinton for the Western subjects and former Chinese premier Zhu Rongji for the East Asian subjects) while undergoing a brain scan. They found that when thinking about themselves rather than the public figure, both groups recruited the MPFC, a key region that is involved in self-representation. However, when thinking about their mother rather than the public figure, Chinese participants also recruited the MPFC but Western participants did not (Zhu et al., 2007). These results suggest that culture influences self-representations in the brain, with Chinese individuals recruiting the MPFC to represent both the self and the mother and Western participants recruiting the MPFC solely to represent the self. These findings provide evidence that differences in self-representation between East Asian (Chinese in this case) and Western (English, American, Australian and Canadian in this study) individuals can be seen not only at the behavioral level but also at the neural level (for further discussion on culture and self–other overlap in neural circuits, see Varnum & Hampton, chapter 18 in this volume).

Another area of interest in cultural neuroscience is the study of emotions. Previous research has shown that culture shapes ideal affect, or the ideal state people would like to feel (Tsai, Knutson, & Fung, 2006). On the one hand, Hong Kong Chinese value low-arousal positive states, such as feeling calm and relaxed, more than do European Americans. On the other hand, European Americans value more high-arousal positive states, such as feeling excited and enthusiastic, more than do Hong Kong Chinese (Tsai et al., 2006). Using these findings, Park, Tsai, Chim, Blevins, and Knutson

(2016) hypothesized that, compared with Chinese participants, European Americans might find faces displaying excited expressions more rewarding than those showing calm expressions. In order to test this, they presented European-American and Chinese participants with faces that showed calm and excited expressions as part of an fMRI task. Their results supported their hypothesis: they found that, compared with Chinese participants, European-American participants showed higher activation in the ventral striatum and caudate, areas related to reward processing, when viewing excited versus calm faces. These neural findings supplement behavioral findings that culture influences the positive affective states that people ideally want to feel and demonstrate that, indeed, the valuation and reward associated with each culture's ideal affective state seems to be reflected in the brain.

In another example, Freeman, Rule, Adams, and Ambady (2009) were interested in studying how the observed behavioral differences in the ways American and Japanese cultures reinforce dominant and subordinate behaviors respectively would be reflected in the brain. To this end, they used fMRI to measure brain activity while American and Japanese participants viewed images that exhibited a dominant or a subordinate posture. They found the same brain regions firing for different stimuli: Americans showed increased reward-related activity in the striatum and the MPFC for dominant versus submissive postures, while Japanese showed the same pattern of activation but for submissive versus dominant postures. In addition, the magnitude of brain activity positively correlated with how much participants valued dominance and submissiveness. In other words, the more a participant self-reported a tendency towards more dominance (or submissiveness), the more reward-related activity was present for the dominant (or submissive) figures. This study serves as an example of how the same stimuli can elicit different activation in the same brain regions, depending on the values reinforced by each culture.

In another study, Telzer, Ichien, and Qu (2015) explored the neural correlates of prosocial behaviors in an intergroup context. They designed an fMRI task in which European-American and Chinese participants were given the option to donate money to a European-American or Chinese confederate. They found that across both cultural groups participants showed increased reward-related activation in the VS when donating to their in-group as opposed to their out-group, which suggests that both groups found it more rewarding to be prosocial towards the in-group than toward the out-group. In addition, they found that those with higher group identity, and Chinese participants more so than American ones, showed more activation in areas commonly related to self-control (VLPFC, ACC) and mentalizing (TPJ, DMPFC) when donating to the out-group as opposed to the in-group. This study illustrates how one can study universal similarities as well as culture-specific differences between groups.

Suggestions for Steps in Designing a Study

This section provides a general guide to the design of cultural neuroscience studies involving fMRI. The first step in designing a study is to identify a psychological process of interest. Some examples of these are emotion, cognition, perception, motivation, decision making, representations of the self, and intergroup relations. For example, one might be interested in testing whether people from different sociocultural backgrounds have different representations of the self. Once the psychological process of interest has been identified, the second step is to hypothesize whether it might vary depending on the cultural construct of interest. For example, Hofstede (2001) provides a list of dimensions by which cultures can be differentiated and that affect human behavior, including power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity, and long-term versus short-term orientation. Cultures also tend to differ in their cognitive styles of thinking. For instance, East Asian cultures tend to engage in more holistic thinking, meaning that they pay attention to the context and how the parts of a whole might be related to each other. In contrast, Western cultures have a more analytic style of thinking, where each part of the whole is independent of the others and of the context (Nisbett, Peng, Choi, & Norenzayan, 2001). In this second step, one theorizes how some of these cultural factors might influence the psychological process of interest. This stage can be informed by theories and findings from cultural psychology. For example, say the psychological process of interest is self-representation. It has been found that representations of the self differ between East Asian and Western societies, the former having a more interdependent self-construal and the latter a more independent view of the self (Markus & Kitayama, 1991), so it is important to make sure that the groups the researchers are comparing differ in the cultural construct of interest, and not to assume that people from the same sociocultural context have the same cultural values. Thus it is important to find and administer a well-validated questionnaire that measures the cultural construct of interest, which in this example is independence–interdependence.

A third step is to hypothesize which neural systems might be involved in the psychological process of interest. For example, if one is interested in cultural differences in self-representation, one might think that there would be differences in MPFC activation when participants from two different cultures engage in a self-referential task. If one is interested instead in how cultures place different value on what they find rewarding, perhaps one would expect to see differential VS activation between cultural groups.

A fourth step is to design a task that gets at the psychological process of interest. For example, if we are interested in studying how people perceive the self in relation to others, we might create a study that asks participants to think about themselves and about others. However, special considerations are necessary when designing an fMRI task, to ensure that the task is getting at the psychological process of interest, which in this case is self-referential processing. To illustrate, if we give participants 10 seconds to think about themselves, they might spend the first 2 seconds doing what they are asked to, but then spend 8 seconds thinking about something else, such as homework (see Figure 16.3). In that case, we end up measuring neural activity induced by something completely unrelated to what we

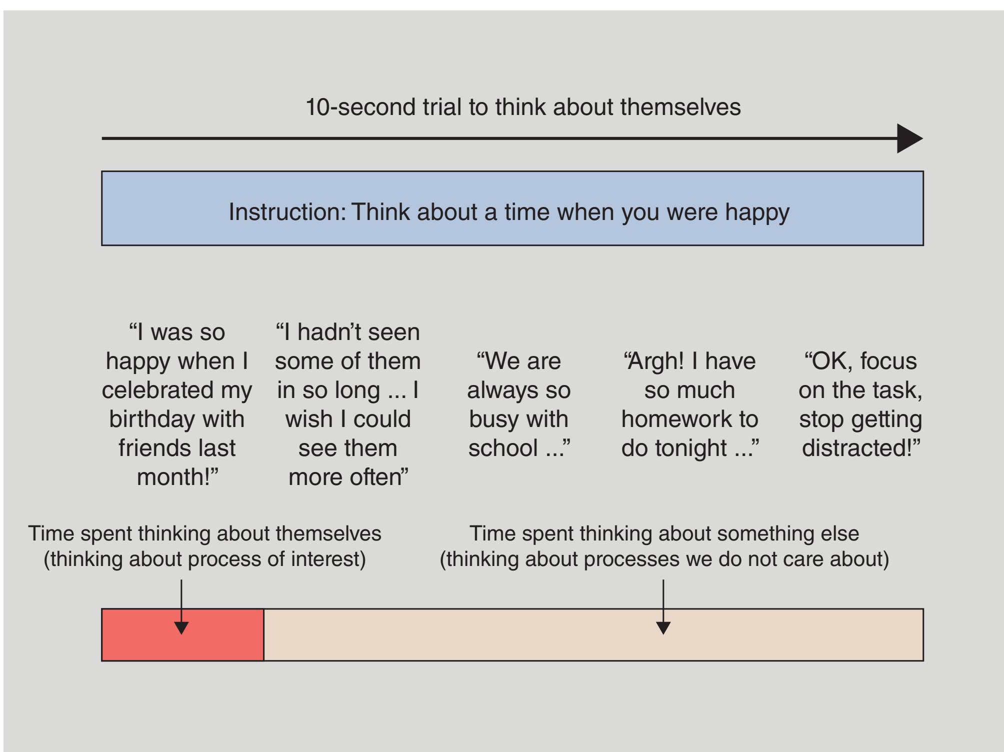

Figure 16.3 Considerations when designing an fMRI task. This example illustrates that it can be hard to isolate the psychological process of interest

want to study. In addition, it is important to make sure the conditions and stimuli we are contrasting are comparable in most dimensions except for one – the one we are interested in. For example, if we would like to examine how people from different cultures might empathize with their in-groups differently, we could present participants from Culture A and Culture B with pictures of their in-groups and ask them to empathize with the people in the picture. In this case, we should ensure that the pictures being presented to the two cultural groups are matched for details such as valence, arousal and background. Otherwise, if one sees differences in brain activation between cultural groups, it might not be because participants from each culture empathized differently with their own in-groups, but rather because the pictures from Culture A were more interesting than those from Culture B and so might activate more attention-related regions than empathy-related regions. These examples illustrate the challenges associated with isolating the psychological process of interest and highlight that a task must be designed with care in order to eliminate the potential confounds presented by processes we are not interested in. Careful thought when designing the fMRI paradigm will increase the validity of the results by ensuring that we are measuring what we are intending to measure, and will also lead to more accurate interpretation of results.

The final step is to analyze the data and interpret the findings. After data collection is done, fMRI data are preprocessed in a series of steps that correct for individual variability to make the data comparable across subjects. Different statistical analyses are then performed to infer if there is differential activation between conditions of interest. As mentioned earlier, before data collection, one might hypothesize which brain regions might be activated by the psychological processes of interest. However, once data are ready for analyses, one should be careful about reverse inferences (Poldrack, 2006), or inferring that because a certain brain region gets activated a particular cognitive function is engaged. In other words, the activation of a region when a certain task is performed does not necessarily mean that the psychological process in which we are interested is involved. For example, if we see MPFC activation in participants from Culture A but not in participants from Culture B when they are doing a self-referential task, we cannot conclude that participants from Culture A engaged in self-referential processing but participants in Culture B did not. All we can say is that there were differences in activation between the two groups in a brain region commonly associated with self-referential processing, and we have to interpret the neuroimaging findings with caution (Schwartz, Lilienfeld, Meca, & Sauvigné, 2016). As with other psychological studies, one should also be aware of possible issues related to statistical power and inflated correlations (Yarkoni, 2009).

Conclusions and Future Directions

Cultural neuroscience has already provided many insights into the relationship between culture and the brain, and has raised several interesting questions for moving forward. However, there is still much to be done. Here we describe some promising avenues for future research.

One of the current limitations in the field of cultural neuroscience is that the vast majority of studies have focused on East Asian and Western samples. While this has given us a very rich understanding of the differences between these two groups, there is still much to be explored about other cultures around the world. In addition, more studies should examine how sociocultural variability and socio-ecological factors, such as residential mobility, might relate to cultural differences within a nation (Ng, Morris, & Oishi, 2013). Inclusion of the study of more cultures within and across nations will provide a more comprehensive view of the behavioral and neural mechanisms that are specific to each culture versus those that are universal.

Another limitation in the field is that most studies in cultural neuroscience have been done on adult samples. Thus, one methodological future direction would be to conduct developmental and longitudinal studies. As previously illustrated, studies in cultural neuroscience have shown that the brain adjusts to its sociocultural context. But the question arises as to whether there is a sensitive period for individuals to become attuned to their sociocultural environment. Are there certain developmental periods when the brain is more receptive to its sociocultural environment than others? And if culture shapes patterns of brain activity early in life, can these patterns be changed later in life? Developmental and longitudinal studies would help answer these kinds of questions by giving us more insights into when and how culture and brain shape each other. For further discussion of developmental considerations in cultural neuroscience, see Miller and Kinsbourne (2012) and Qu and Telzer, chapter 19 in this volume.

Another future direction would be to use different techniques to analyze fMRI data. The most prevalent way in which fMRI data is currently analyzed is through univariate methods, in which the overall mean activations in brain regions between conditions of interest are compared. However, given that brain regions do not operate in isolation, it is also important to look at how different regions are connected to each other and how they function together. In other words, it is important to focus not just on a single brain region but on brain networks. For example, it is possible that two cultures show similar overall brain activation in two regions, but use those regions differently at the network level. That is, the way the two regions are interconnected and communicate with each other might differ between cultures. Another way to study culture and brain interactions, which has not been done extensively in the field, is to look at the connectivity between brain structures rather than at brain function. One way to study this would be to examine the neural connectivity in structural white matter tracts between groups by using techniques such as diffusor tensor imaging (DTI), or to examine functional connectivity by using task-free resting-state scans.

An area of research that is also part of the field of cultural neuroscience but is not explored as much as brain activity is neurogenetics (Chiao & Ambady, 2007), or the study of how genes influence the formation of the nervous system. Doing more research in this area can help us understand how genes can regulate brain development across cultures, which would give us a deeper understanding of how culture can influence not only our neural activity but also our biochemistry. Cultures differ in the frequency of alleles, or variants of a gene (Chiao & Blizinsky, 2010; Luo & Han, 2014), and evidence has shown that these differences can even have an influence on cultural values and neural activity depending on the variant of the gene (Ma et al., 2014). Thus, combining neuroimaging and neurogenetics approaches might give us a greater understanding of how biology and culture interact and give rise to social behaviors, and can also help disentangle the effects that are cultural from those that are genetic (Hyde, Tompson, Creswell, & Falk, 2015). Moreover, imaging genetics has important implications for physical and mental health outcomes (Chiao, 2009), and thus future studies should consider how culture–gene interactions influence neural processes and their potential links to population health (Chiao, 2009; Chiao et al., 2013). For a discussion of culture and genetics, see Causadias and Korous, chapter 7 in this volume.

In conclusion, this chapter introduces readers to some of the most commonly used concepts and methods in the field of cultural neuroscience, and highlights ways in which cultural neuroscientists have studied cultural influences on neural activity. One of the greatest strengths of this field is that it sheds light on the interplay between culture and biology. Given the interdisciplinary nature of cultural neuroscience, we believe that a stronger integration among fields, including cognitive neuroscience, developmental psychology and neurogenetics, will lead to a greater understanding of the bidirectional influences of culture and brain. These future directions would give us a more complete picture of how culture and biology interact to shape the mind and the brain.

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